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Reducing Container Operational Cost at the Klaipeda Container Terminal

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Abstract

Current economy is constantly developing, and the amount goods transferred by maritime carriers is constantly growing respectively. However, the increase of marine transport means the increase of the container operational costs for the carrier. In order to decrease the costs, the study has been conducted for CMA CGM Group to have a better understanding of the situation in Klaipeda Container Terminal regarding container operational costs.

The main goal was to figure out how to reduce container operational cost at Klaipeda Container Terminal. In order to answer that 3 questions for Klaipeda Container Terminal, must be answered: "What is the average imbalance?", "How to read storage position?", "How the container storage cost can be reduced?".

The research is based was based on the data provided by CMA CGM Group. Quantitative approach was used to collect numerical data in order to generate reliable answers. The data was collected from the Klaipeda Container Terminal stock report and CMA CGM Group ERP data.

Based on the answers on 3 previous question, conclusion on how total container operational cost can be reduced at Klaipeda Container Terminal. At the end of the research, the formula is created based on the factors that are affecting container operational cost.

The researcher encourages for the future research in the field of container operational cost not only for Klaipeda Container Terminal but other ports under the scope of CMA CGM Group as well. Additionally, potential challenges were mentioned in the discussion as well.

Keywords/tags (subjects)

Container, maritime, depot, terminal, storage, improvement

Miscellaneous (Confidential information) Confidential information must be marked clearly stating which appendixes are confidential and what the confidentiality is based on and how long the period of secrecy is. For example***: Appendixes 1, 4 and 7 are confidential and they have been removed from the public thesis. Grounds for secrecy: Act on the Openness of Government Activities 621/1999, Section 24, 17: business or professional secret. Period of secrecy is 25 years and it ends 01.06.2045.***

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1 Introduction

1.1 Maritime

It was estimated in 2018 that the world maritime trade increased by 2,7%. The historical average is 3%. Even though, the growth has been steady for the past years, it decreased during 2019 due to the political activities, such as ongoing trade war between United States and China. The estimated growth during the period of 2019 – 2024 is 3,4%, which is slightly higher than the previously estimated. Figure 1 below, represents the cargo ton-miles during the period of 2000 – 2019. It can be seen in Figure 1 that shipping had a constant development during each year except for 2009 when the world financial crisis happened. The increase of cargo flow during the past years means an increased number of containers and vessels respectively and therefore, better understanding of the costs that are behind those processes is required, otherwise the companies' expenses will increase, and they will lose profit. (REVIEW OF MARITIMETRANSPORT, 6)

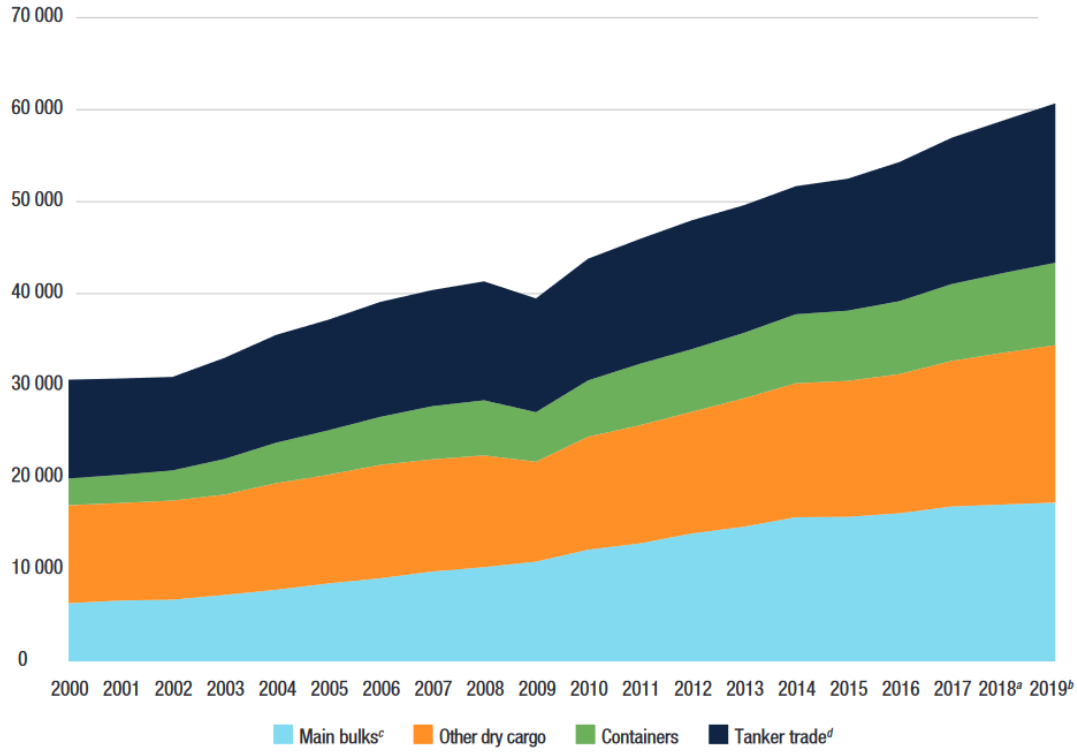

Figure 1. International Maritime Trade in Cargo Ton-Miles, 2000–2019 (REVIEW OF MARITIMETRANSPORT, 6)

1.2 Research questions

The goal of this study was to gain a deeper understanding of the costs of the container operations at the Klaipeda Container Terminal. By answering three questions and combing the outcome, container operation optimization was achieved. There were three main research questions:

What is average imbalance of the containers in the Klaipeda Container Terminal? Gathering the information from the company's system in order to understand the number of full containers flowing in and out.

How can storage position at the Klaipeda Container Terminal? Analyzing stock reports of the Klaipeda Container Terminal, what is included and why container position is one of the main parameters that should be considered when optimizing costs.

How can container storage costs be reduced at the Klaipeda Container Terminal? For this purpose, a formula was created based on the current container position and other operational variables.

1.3 Research Method

The study familiarized with the current situation of the CMA CGM Group, particularly with Finland and the Baltic Cluster, which includes the countries of Finland, Estonia, Lithuania, Latvia and Belarus. The focus was on activities from the ILS and operations point of view and on how to improve the container operations, reduce idling days and decrease the containers' operational costs. The study explains how to read the stock report from the Klaipeda Container Terminal, how to read the storage position and how to utilize it in the future regarding container accessibility.

The purpose of the research was to provide CMA CGM Finland Oy ILS and Operations with a possible solution for identifying the idling containers and for how the operational costs could be reduced. In order to better understand the underlying costs, new formula had to be created, which would identify the idle unit and advise how profitable it would be to use a specific container. Therefore, the research method contained:

- **Gathering and analyzing export and import data for the Klaipeda Container Terminal**. This allowed to understand the number of containers that were flowing in and out the terminal.
- **Gathering stock reports from the Klaipeda Container terminal**. Extracting a terminal stock in an Excel compatible file formal.
- **Analyzing stock reports and explaining how to read the stock**. This step allowed to have a better understanding of how to read the stock and what the main points or KPIs were to which attention should be paid.

- **Creating a formula with variable values that will advise if it is profitable to use an exact container**. The formula emphasized the main cost related variables in the container operations and how they could be compared and at some point in the future reduced.
- **Explanation of formula and examples where it can be used**.

In order to answer the above-mentioned questions, the research process included descriptions of different inventory models, such as Push and pull in order to understand which model would be more suitable for Klaipeda's stock maintenance. Theoretical background of the forecasting and KPIs was included as well. Based on the KPI's theoretical background, it was possible to identify the main KPIs at the Klaipeda Container Terminal and how were they related to the cost operational issues. The topic of optimizing the Klaipeda Container terminal was chosen based on the high import and export activities in Finland and the Baltic Cluster. The terminal is also used as the storage and transshipment hub for some of the units. Therefore, the number of containers stored at the terminal is the biggest within the whole area. The above-mentioned theoretical parts provide a better understanding of the processes behind the operations at the Klaipeda Container Terminal.

2 The CMA CGM Group

2.1 The CMA CGM Group as company

The CMA CGM Group is a leading word wide transportation company and logistics group. The current president is Rodolphe Saade. The Group is present in more than 160 countries through 755 agencies, 750 warehouses and 110,000 employees. The company is equiped with the young fleet of morre than 500 vessels. The CMA CGM Group serves 420 commercial ports, approximately 75% of the commercial ports in the world and operates on more than 200 shipping lines. The company is one of the player driving the globalization of the market. The main vision of the company is ''Shipping the Future''. The CMA CGM Group consists of seven different maritime

companies, presented in Figure 2, where each of them acts as an agent of the CMA CGM Group in their own region. (The CMA CGM Group website)

Figure 2. The CMA CGM Group (The CMA CGM Group website)

2.2 The CMA CGM Group's maritime activities

The CMA CGM Group is trying to change the industry of maritime transportation through an Ocean Alliance. It is one of the largest operational shipping agreements that has ever been signed. An alliance was signed in 2017 for the period of ten years. The agreement includes four renowned shipping companies: The Evergreen Line, China Cosco Shipping, OOCL and CMA CGM. It includes 38 services on East-West trades and 330 ships, where 123 vessels are provided by the CMA CGM Group. The goal of the partnership is to improve transit time and to provide better services for vessels, ports and rotations. The CMA CGM Group's basic information is presented below in Table 1 (The CMA CGM Group website).

Table 1. The CMA CGM Figures (The CMA CGM Group website)

CMA CGM Group 2016	
Total Revenue	USD 16 billion
Number of Containers Carried	15,6 million TEUs (twenty-foot equivalent units)
Total Fleet Vessels	445
Total Fleet Capacity	2,208 million TEUs
Staff Worldwide	29000 employees
Staff in France	4500 employees

Ocean Alliance is a part of the new CMA CGM Group's strategy. By combining with The CMA intermodal infrastructure, such as trains, barges' inland depots and road transportation it is steering the CMA CGM Group to the new heights and challenges. (The CMA CGM Group website)

2.3 Current situation at the CMA CGM Group

3 Iventory management systems

Stock is used for planning between supply and demand. In most cases, stock is used as a safety buffer between the arrival of the next supply and releasing the products to the customers. It can be used in order to cover mistakes or other possible delays or variance. The main reason for carrying a stock is to keep the business running. (Emmett & Granville 2007, 1.)

The following chapters are an introduction to various popular inventory steering modules that were considered and applied in the research. One of the possible inventory modules is the traditional push method that relies on the Reorder point formula. The pull system consists of lean management and a just-in-time approach. Both approaches have many similarities, where the goal is to reduce the stock and carry costs respectively.

3.1 Push system

The push system relies heavily on forecasting. The business goal is to forecast how many units of a specific product the company will need during the next month, quarter or a year. The final goal is to produce or purchase enough units to cover the demand. (Benton – 2013, 202.)

One of the main disadvantages of the push system is the same as its advantage – relying on forecasting. The forecasts are in general inaccurate. Therefore, many products are left in the inventory unused. The company must wait for the next period to sell this excessive stock. Excessive stock leads to the increase storage costs. (Hunt – 2019.)

In order to create an optimal stock, a Reorder Point formula is used. This allows to take into consideration the varying customer demands. It is one of the most widely accepted methods. While the reorder point is customized for the business needs, the formula remains the same every time. The description of each variable in the formula is presented in Table 2 (Richards & Grinsted – 2013, 132.) and the impact of the Reorder Point formula is visualized in Figure 3. (Katana – 2019.)

$$Reorder\ Level\ =\ Safety\ Stock\ +\ Average\ Daily\ Usage\ *\ Lead\ Time$$

Table 2. Reorder Level Variables (Richards & Grinsted – 2013, 132.)

Safety stock	A minimum level stock maintained in order to prevent stockouts or stock falls.
Average Daily Usage	Daily quantity of the item that has been utilized or sold.
Lead Time	The period the supply order has been placed and goods arrive physically to the final place of delivery.

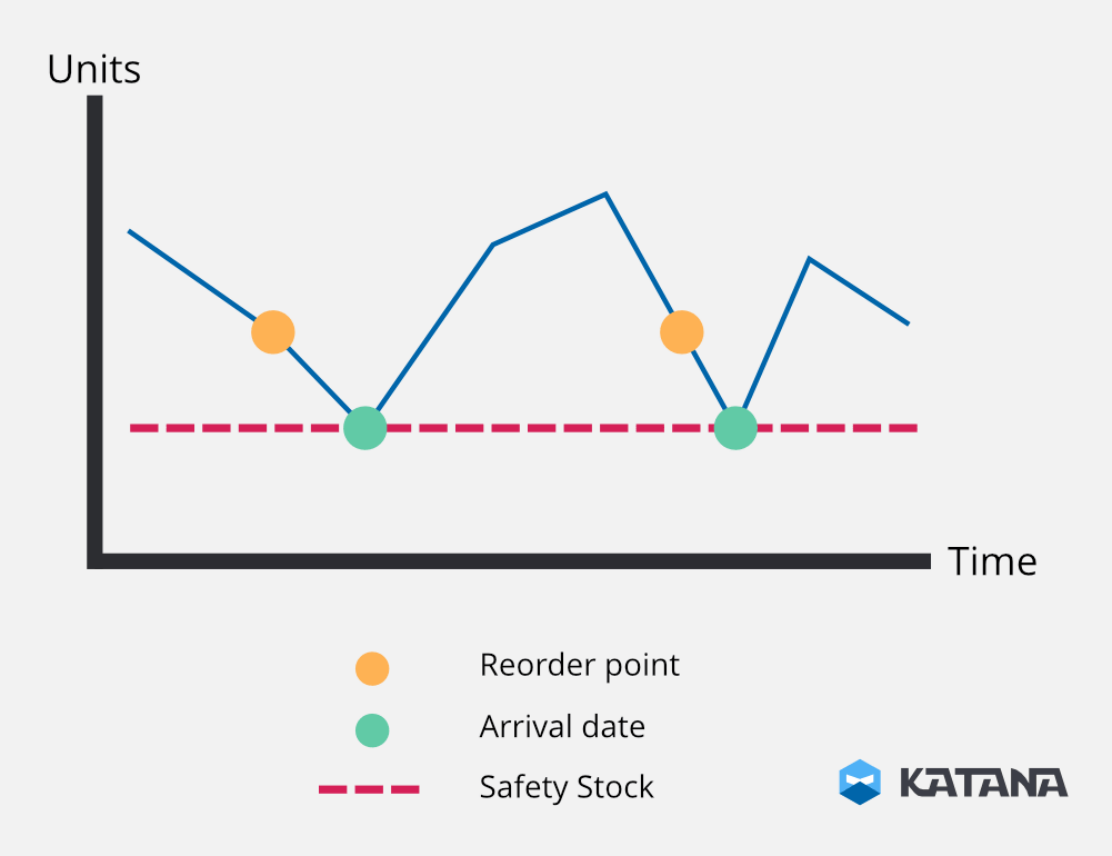

Figure 3. Reorder Point (Katana - 2019)

Tuomas Lampinen (2011) has defined the method to calculate the Safety stock by using below mentioned formula. The formula uses the Safety Factor variable. A safety Factor (K) can be calculated by using =normsinv(probability%) Microsoft Excel formula or extracted from the already pre-existing Table 3.

$$Safety\ stock = K * Standard\ Deviation\ of\ Demand\ Over\ Lead\ Time * \sqrt{Lead\ time}$$

Table 3. K Factor (Tuomas Lampinen – 2011, 25.)

K – Safety Factor	0,5	1	1,5	2	2,5	3
Cumulative	69,15 %	84,13 %	93,32 %	97,72 %	99,38 %	99,87 %

3.2 Pull system

The goal of the pull system is to keep the stock at the minimal level. Instead of relying on forecast, as in the push system, the stock is kept at the minimal level and reorders are made based on what the customer has already ordered. This prevents overordering and allows savings in warehousing costs and reduces wastes. (Benton – 2013, 203.)

3.2.1 Lean management

Lean management is a philosophy developed from the Toyota Production System and other best industrial practices. The main idea of a philosophy is to produce less of everything compared to the push system. Such production system can be achieved by reducing waste. According to Toyota Production System, waste is an expense that does not generate value-added services or contribute to the final outturn of the product. Seven wastes are presented below:

- Overproduction

- Excessive inventory
- Waiting
- Transportation
- Unnecessary motion
- Over-processing
- Defects

(Wang - 2010, 1-2)

Just-in-Time

Just-in-Time is a systematic approach where materials are ordered and delivered to the factory, place of production or place of need right before than they are required. Companies employ this inventory strategy to reduce costs, known as waste, and to increase efficiency. Such strategy requires accurate forecasts of demand. (Just in Time (JIT) - 2020.)

Benefits of Just-in-Time

The main benefit of the JIT approach is low inventory costs. Warehousing cost are one of the main problems in logistics nowadays. Storage costs can refer to an exact building or to the land that is rented for specific production purposes. The logistics design of a maritime company must maintain the inventory cost of the empty containers at low as possible. (Nadege Chia Angbo - 2008, 18.)

Another benefit of the JIT is improving lead time and improving utilization rate. Its approach emphasizes on smooth operations, where equipment or material is supplied only when needed. The logistics network is designed in the most possible flexible way according to the supplier or customer's needs. (Lai, Kee-hung - 2009, 20.)

Next benefit is related to the foster organizational discipline. Everyone in the organization should belong to one team and act together. Suppliers and customers must

also be involved in the conversation as based on their needs is planned Material Requirement Planning (MRP) (Lai, Kee-hung - 2009, 21.)

MRP stands for Material Requirement Planning, and it is an inventory management system where the whole cycle is divided into the current inventory, lead time and the quantity required. MRP relies on three main questions: ''What is needed? How much is needed? When is it needed?''. By Answering 3 questions the future supplies and materials flows are generated. (Arnold, Chapman, & Clive - 2012, 352.)

Limitations of Just-in-Time:

One of the main drawbacks of the JIT approach is keeping the stock low or without a safety buffer. Therefore, it brings a significant pressure on the whole cycle where the whole chain is responsible for a proper rotation. It is quite challenging to achieve as the whole company has to act like one single organism. (Lai, Kee-hung - 2009, 25)

According to Hall (1989) another downside of the JIT approach is that the absence of a buffer makes it incapable of coping with a sudden demand change. JIT is very sensitive to errors. Whenever a supplier or another party has made a mistake, the whole supply chain cycle is affected. Last, but not least, effective cooperation with other companies is required. When we are talking about big companies very close communication is the factor of success. (Lai, Kee-hung - 2009, 25)

3.2.2 How JIT can be applied in Maritime Trasnport

It is clear from the first look that Just-in-Time is no correct solution for maintaining a stock on the level of one of the biggest maritime companies in the world. However, JIT's principles can be utilized to reduce costs. One of the main goals of JIT is to reduce storage costs. Every company nowadays is looking for waste elimination and cost cutting, and the CMA CGM Group is not an exception. The Group holds different agreements with each terminal. Each contract is unique, and the charges, rights, and liable parties are different. For example, at on terminal's storage cost, the costs can be dependent on the days that an empty container is at the terminal's premises.

These kinds of terminals can be utilized as the main hubs for supplying other regions if there is a vessel connection available. Terminals with high storage costs can maintain a small safety buffer and be fully dependent on supply from the main storage hub. By assuring equipment rotation, costs can be minimized significantly.

In the maritime resources are the containers and their spare parts, such as genset, special cleaning, maintenance, and repair services. Containers are moved by vessels between the terminals which can be identified as production premises.

Genset, short for a generating set, is a comprising generator and diesel engine mounted on a common base frame. All gensets are designed to operate on standard marine fuel oils. The generator is usually connected to a specific container to support its operation. Voltage can be selected and modified based on needs. (Wärtsilä generating sets)

3.3 Demand Forecasting

Demand forecasting is the process of analyzing historical data which is later used to develop and estimate the expected future volume of demand. However, forecasting provides only an estimation of the services or products that customers will purchase in the future. Later, that data is used to form a rough estimation of the workflow, capacity, profit margins, cash flows etc.

Demand forecasting is divided between 2 types: Qualitative and Quantitative. Qualitative forecasting relies on two main points. The first is the sale force opinion, where the sales team is requested to input their expected demand in the forecast. Secondly, market research is applied, where customer specific surveys are integrated in order to generate potential demand.

Quantitative forecasting relies on the data from the past history in order to predict the future. It is accomplished by analyzing statistical and economic indicators. By

gathering a large data history, it is possible to identify seasonal trends. (Oti-Yeboah – 2019.)

Nada Sanders (2015), identifies seven steps of the forecasting process to follow, regardless of the forecasting model being used:

1. Decide what to forecast. It includes:
    a. Address the real problem. Forecast are generated in order to foresee the answer to a question.
    b. Identify the time period to cover
    c. Identify data collection points
    d. Define the unit of measure
2. Clean Data. Forecasting is 100% dependent on the analyzed data. The forecast will reflect every mistake in the data. Therefore, the data has to be credible. The most common data errors occur due to missing data or mismatches in current money values.
3. Data pattern identification. The most common patterns are presented Figure 4 below:

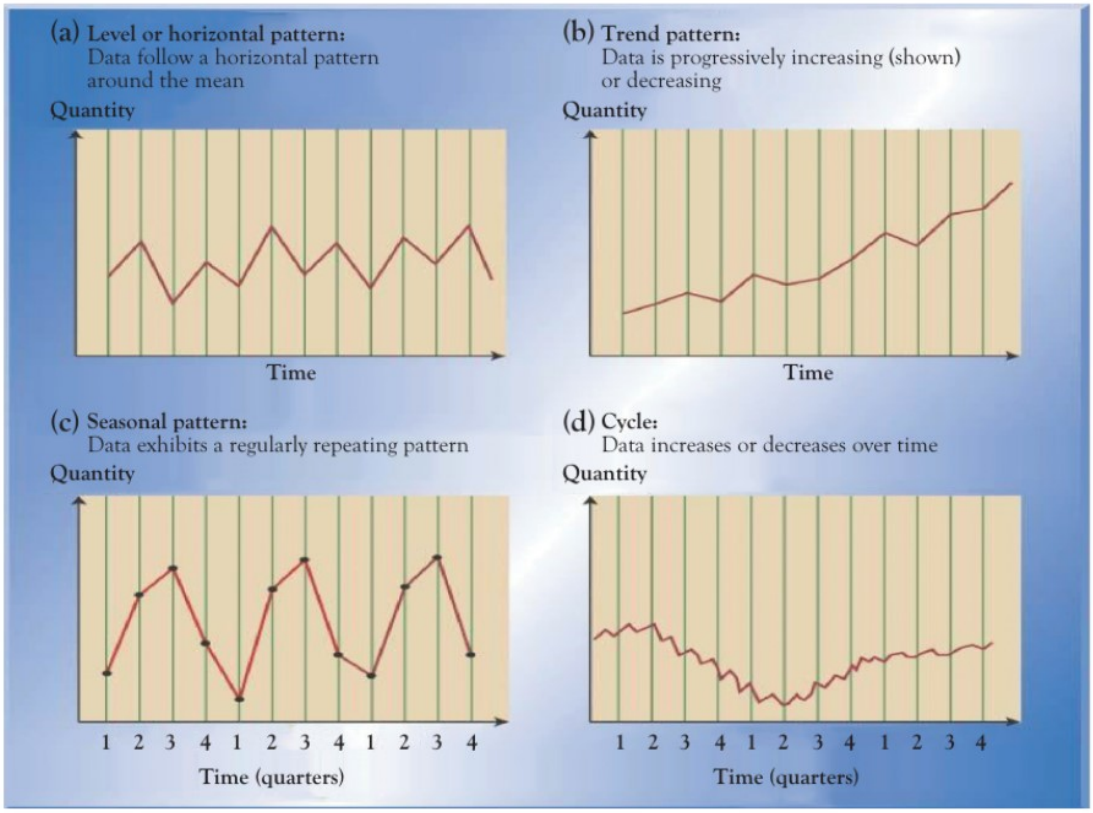

Figure 4. The Most Common Data Patterns (Sanders – 2015, 23.)

4. Select a model. When choosing a model, it is important to consider such factors as the type and amount of data available, accuracy range, forecast length and the data patterns.
5. Generate the forecast
6. Monitor accuracy of the forecast. After a forecast has been completed it is important to check forecast errors after the event have occurred. Later the information can be used to improve further forecasts.

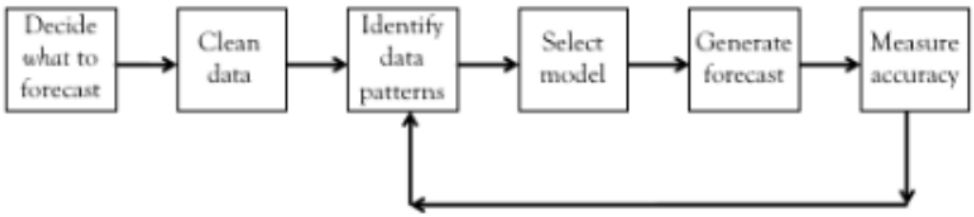

Figure 5. Forecasting Process (Sanders – 2015, 220)

3.3.1 Trend Projection Method

The trend projection method is a classical forecasting method, where a large amount of reliable data is required for demand estimation. The trend projection method includes such factors as sales and demand. One of the main disadvantages of this type of forecasting is the assumption that past trends will remain at the same level. In the trend projection method, forecasts are made based on the extracted data for previous months or years. The method uses different time groups. The easiest trend projection method to follow, read and analyze is the Graphical method. In the Graphical method the Y axis represent the demand. The timeline is presented on the X axis. The example of Graphical method is presented in Figure 6. (Nitisha – 2019.)

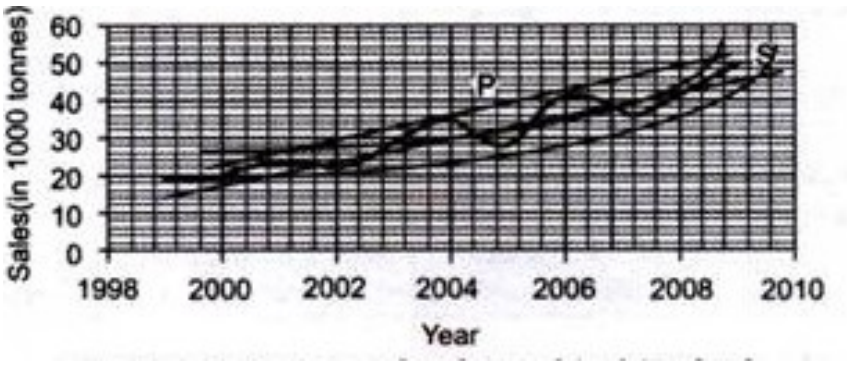

Figure 6. Graphical Method (Nitisha – 2019.)

3.4 Key Performance Indicators (KPI)

Key performance indicators are the measurements that focus on the different aspects of companies or organizational performance that are the most crucial for successfully running a business. One of the main problems with KPI is that many companies use the wrong measurements, where most of them can be mistakenly taken as KPI. Not many companies monitor their KPIs. Therefore, there are four types of performance measurements:

- Key result indicators (KRI) advise how the company has performed in perspective of the crucial factors
- Result indicators (RI) advise what has been accomplished

- Performance indicators (PI) advise what should be done
- KPI advise what action should be taken in order to increase performance significantly

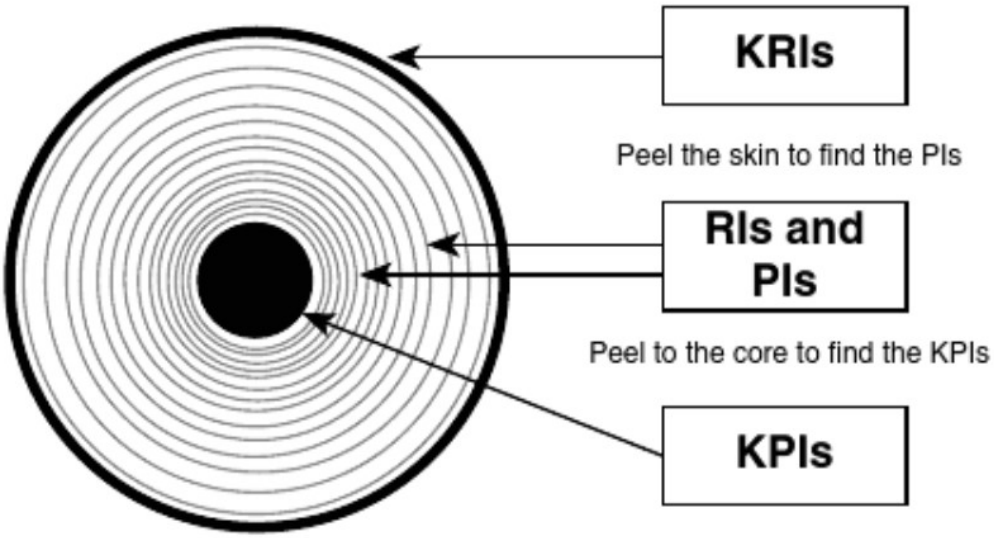

Figure 7. Four Types of Performance Measures (Parmenter - 2010, 2.)

Considering Figure 7, the outer level represents KRIs which represents the key results. The closer we go to the center, RIs and PIs are becoming visible. By identifying and analyzing RIs and PIs, KPIs are recognizable – the core of the chart. (Parmenter 2010, 2.)

David Parmenter identified 7 main characteristics of KPIs:

- Nonfinancial measure
- Measured frequently
- Acted on by the CEO and senior management team
- Advises what action should be performed by the staff
- Responsibility is tied to the team by the measurements
- Have a significant impact
- Encourage appropriate action

If the KPI does not comply with these characteristics, then it is possible that this measurement is not for this business, even though it might seem important to measure. (Parmenter - 2010, 6.)

3.5 KPIs in Warehousing

It is impossible to specify the benchmark rule for measuring KPIs for every warehouse, as it depends what is the company after and what do they consider the most crucial aspect. The warehouse KPIs reflect the value of the warehouse operations and can be used to identified operational inefficiencies. One of the most common warehouse KPI that is measured is Inventory Turnover. (The Importance of Measuring Warehouse KPIs and Metrics, 2017)

$$Inventory\ Turnover\ =\ Cost\ of\ Total\ Goods\ Sold\ During\ a\ Period\ /\ Average\ Inventory\ Value$$

$$Carrying\ Cost\ of\ Inventory = Inventory\ Carrying\ Rate\ (how\ long\ a\ product\ stays\ in\ the\ warehouse) * Average\ Inventory\ Value$$

4 Methodology

The objective of the study is to provide the CMA CGM Group with the tool to identify the factors that are affecting container operational costs at the Klaipeda Container Terminal. The storage costs reduction is a part of reduction of total container operational costs at the terminal. The most suitable approach is quantitative due to the research defined problem. Quantitative research refers to analyzing a numerical data or data that can transferred into numbers. The data can be collected through questionnaires, polls, surveys or already existing numerical data. After data has been gathered, it is tended to be generalized for the large group population or to explain a

particular phenomenon. The purpose of the quantitative research is answer questions “How many?” “How much?”. (Babbie, Earl R. 2010)

The numerical data represented in the research has been extracted either from the CMA CGM Group’s ERP, export and import activity, or from the Klaipeda Container Terminal system, the stock file. The stock file has been provided by the terminal by the email as a part of daily information for the respective partner company.

As the result of quantitative study, the research questions have been answered. The container import and export activity data extracted from company’s ERP was analyzed by using chart where a reorder point is set, by suing reorder point formula described in chapter 3.1. The stock report proved by the Klaipeda Container terminal in the Microsoft Excel format was analyzed. The main information that is extracted from the file is the storage position and how it is defined. Other valuable parameters are explained as well. The analysis was performed by creating the Microsoft Excel VBA in order to have fast accessibility. Finally, a formula was built with the explanation of the variables which automatically advises what action should be taken regarding the specific container inserted. The variables in a formula are defined based on the personal experience of the researcher during an academic year of completing the research.

A conclusion answers for the previously defined research questions in a Chapter 1.2. After each question has been answered separately, all research questions are combined, and all overall conclusion is generated. After conclusion, the future development is discussed whenever a research can be expanded to the other areas where the CMA CGM Group is present. The challenges of expanding a research are also defined. A methodology’s flow chart can be followed in Figure 8 below.

Figure 8. Methodology

Current expenses at the CMA CGM Group

Table 3 represents the CMA CGM Group operational expenses during the years 2016, 2017, 2018 and 2019. All costs are represented in millions of USD. The trend of increase operational costs is clearly stated in Table 3. Additionally, the container operational costs related to the research are:

- **Handling and stevedoring**
  It is related to the equipment handling and storage at the terminal, depot or port.
- **Container equipment and repositioning**
  It is related to the container rental costs and its repositioning from point A to point B

Combined above 2 mentioned costs are generating 29.5% of the CMA CGM Group's total operational costs for 2019. Respectively, as group is planning on expanding its container fleet and container traffic in the world, an operational cost continues to increase exponentially.

Table 4. The CMA CGM Group operational expenses (The CMA GGM Group website)

Expense	**2019**	**2018**	**2017**	**2016**
Bunkers and consumables	3450,7	3618	2568,5	1702,7
Chartering and slot purchases	1390,3	2351	2064,4	1986,6
Handling and stevedoring	6385,5	6266,4	5547	4457,4
Inland and feeder transportation	6577,4	3323,4	2918	2191,6
Port and canal	1457,9	1526,6	1334	1193
Container equipment and repositioning	1427,2	2127,7	1731,3	1448,9
Employee benefits	4063,1	1879,5	1699,7	1495,4
General and administrative other than employee benefits	1361,0	848,1	729,3	668,7
Additions to provisions, net of reversals and impairment of inventories and trade receivables	51,9	32,6	37,0	+14,3
Others	330,1	354,0	442,7	350,3
Total operational expenses	**26495**	**22327,4**	**19071,9**	**15480,3**

5 Container Operations at the Klaipeda Container Terminal

5.1 The measure of the container

The standard measure of every container equipment in a maritime field is TEU. (20'/twenty-foot equivalent unit). Subsequently, each container has its own dimension. 20' refers to 20-foot container and it equals to 1 TEU. 40' is a 40-foot container – 2 TEUs. The measurements of TEU unit is presented below in Table 4. (What is the TEU (« Twenty-foot Equivalent Unit")?)

Table 5. TEU Measurements (What is the TEU (« Twenty-foot Equivalent Unit")?)

Amount of TEU	Length	Width	Height	Inside Volume
1 TEU	20 ft (6,1m)	8 ft (2,44m)	8 ft 6 in (2,59m)	1172 cu ft (33,2m^3)
2 TEU	40 ft (12m)	8 ft (2,44m)	8 ft 6 in (2,59m)	2389 cu ft (67,6m^3)

5.2 How to identify the container by its name

Table 5 below presents an explanation on how to understand and read container different types and dimensions. Figure 9 presents the physical appearance of different type containers at the CMA CGM Group fleet.

Table 6. 20'ST Unit Explained

20’	20-foot equal container. 1 TEU
ST	Standard unit

Types of equipment:

- GP (General purposes container) also refereed as ST (standard unit) or 20’Dry.
- HC (High cube container)
- FF (Flat rack). Also refereed as 40’FL (flat) or 40’FR
- HCPW (High cube pallet wide). Also refereed as 20’HW (High wide)
- RH (Refer container)
- OT (open Top)
- TK (Tank container)

Figure 9. Types of containers (The CMA CGM Group website)

5.3 Containers at The CMA CGM Groups fleet

The container fleet of The Group as any other maritime transportation company mainly consists of GP/ST, HC and HCPW. The reason for this is high manufacturing price of special equipment (RH, FF, OT, TK) and rarity of usage. The rates for such a container are usually higher. The demurrages and free time at the depot for the clients are also significantly bigger than for standard equipment. Additionally, container’s machinery functionality is dependable on the electricity or on the gasoline/diesel. The temperature of such laden units is monitored by the terminal and

vessel crew every few hours, in order to notice the malfunctioning and find the solution as soon as possible. All those actions require additional labor cost. The terminal is monitoring laden reefer containers based on the agreement with the CMA CGM Group. The agreement includes temperature monitoring of the container due to the high cargo value in those containers. More detailed dimensions, payload and other critical information of the containers is presented in Figure 10 and Figure 11.Therefore, the amount of idling special equipment is low compared to other types. Usually the company pays high attention to these containers and does not allow them to idle. The container is either empty repositioned to the region in need or utilized for the export booking.

Technical Data

	20' x 8' x 8'6"	40' x 8' x 8'6"	40' x 8' x 9'6"	45' x 8'x 9'6"
Size and Type grouping code	**20GP**	**40GP**	**40HC**	**45HC**
Dimensions & type code	**22G1**	**42G1**	**45G1**	**L5G1**
Internal dimensions				
Length (mm)	5,900	12,034	12,034	13,556
Width (mm)	2,352	2,352	2,352	2,352
Height (mm)	2,393	2,395	2,700	2,700
Door opening				
Width (mm)	2,340	2,340	2,340	2,340
Height (mm)	2,280	2,280	2,585	2,585
Nominal capacity (cu.m.)	**33.2**	**67.8**	**76.4**	**86.0**
Maximum gross weight (kg)	**30,480**	**30,480/32,500**	**30,480/32,500**	**30,480**
Average tare (kg)	**2,230**	**3,720**	**3,900**	**4,700**
Maximum payload (kg)	**28,250**	**26,760/28,780**	**26,580/28,600**	**25,780**
Securing rings				
Quantity	20	32	32	40
Resistance (kg/each)	1,500	1,500	1,500	1,500

Figure 10. Dimensions of the Equipment Part 1

Pallet capacity

	40' HC	40' HC PW	45' HC	45' HC PW
1 m x 1.2 m pallets	21	24	24	26
1.2 m x 0.8 m Europallets	25	30	27	34

Technical Data

	40' x 2462mm x 9'6"	40' x 2462mm x 9'6"
Size and Type grouping code	40 HW	45HW
Dimensions & type code	4EG0	LEG0
Internal dimensions		
Length (mm)	12,095	13,624
Width (mm)	2,444	2,420
Height (mm)	2,692	2,687
Door opening		
Width (mm)	2,400	2,360
Height (mm)	2,584	2,580
Cubic capacity (cu.m.)	79.60	85.25
Maximum gross weight (kg)	34,000	34,000
Tare weight (kg)	4,260	4,980
Maximum payload (kg)	29,740	29,020

Figure 11. Dimensions of the Equipment Part 2

Even though the CMA CMG Group has significant number of containers, not all units belong to the Group. Some part of the fleet that the Group has the control of is sub-leased from the other container companies. Leasing can be a short term, from few years or month and up to a long-term leasing, for many years, with the purchase option in the future. During this time lease usually is responsible for keeping container in a sound condition and perform repairs if required. After leasing period has ended container company can offer for subleasing equipment again to the same or different company or use it for their own need and retire the container in the future.

The most common container types that are in the CMA CGM Group usage were presented above. However, there are also 2 different business models, where the container does not belong to the CMA CGM Group and the company does not have the control over them as in the cases mentioned above.

5.3.1 One-way units

There are one-way units. OWAY is a one-way unit that belongs to another shipping companies and leased by the CMA CGM Group. The unit has the same characteristics as an average long-term lease unit. One-way unit is used for single shipment and then returned to pre-defined place

Shipper's owned units

Additionally, the company ships shippers owned units, later referred as SOC units, under export booking. SOC unit is a container that is not owned by the CMA CGM Group. Such containers are agreed to be used to carry customer's cargo to the port of destination. After cargo is unstuffed empty container logistics is the container owner's responsibility.

5.4 Why does container utilization rate need to be improved?

For each depot, terminal or port separate agreement between the CMA CGM Group and the terminal is settled. There is no specific rule describing what charges are applied for each container. Considering the economic situation of the country, charges for approximately the same operation are significantly different. It depends on the labor price, when operation is performed and many other factors that applies only to a specific country.

A storage cost factor is one of the most common factors for the depot. Usually, every terminal provides free days at the terminal for an empty container. By ensuring good utilization rate of current equipment and good rotation of new coming, the storage cost at the terminal can be minimized.

Other possibility is that terminal does not provide free time for containers but provides certain amount of TEU for free. The example can be 500 empty TEUs for free and for 501st TEU the charge of one EUR per day is applied.

5.5 Container terminal operations

Since 1960 container terminals had a fundamental change. Introduction of containerized transportation had changed market dramatically, when majority of cargo has changed from break-bulk cargo. Containerships did not carry any longer cranes onboard. Terminals had to invest a significant amount of money into the crane installation on its territory in order to provide services for the vessels. Additionally, terminals have to provide storage place for the container storages. Nowadays, the average dwell time of a containership is only 24 hours. Equivalent break-bulk cargo ship spends ten times more time in the port in comparison to the containership. (Jean-Paul Rodrigue – 2020.)

There are 2 ways how containers appear at the container terminal: from the vessel or from the inland gates. Full or empty containers are discharged from the vessel with the crane and then positioned to the container stock, which usually different for the empty and full units. Stock is presented in Figure 12 below as Stack with RMG. After containers have been moved to the stock, full units are loaded to trucks or rails and leave to the customers premises for unloading. After that empty units are returned to the terminal and placed back in the stock. When the customer places a booking, trucker comes to the terminal and picks up a unit empty. After customer has stuffed the container, the unit is returned full to the terminal and later loaded on the vessel with the cranes. (Steenken, Dirk, Voß, & Stahlbock - 2004, 13.)

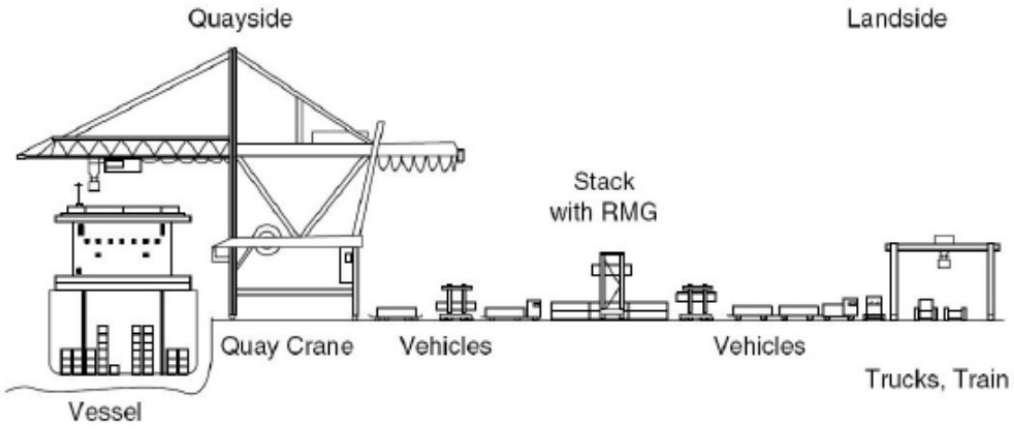

Figure 12. Container Terminal Layout (Steenken, Dirk, Stefan Voß, & Robert Stahlbock – 2004, 13.)

5.6 Terminals

The CMA CGM Group is present at the below mentioned terminal in countries of:

- Lithuania
- Latvia
- Estonia
- Finland

5.7 The Klaipeda Container Terminal

The Klaipeda Container Terminal (in Lithuanian Klaipėdos Konteinerių Terminalas) is the largest port of Lithuania and one of the few northernmost ports that are ice-free. There is also the largest number of containers among other ports of the CMA CGM Group Finland and the Baltic Cluster. The benefits of this port are the destinations where the cargo can be shipped. It is possible to have a short sea service.

Short sea shipping (SSS) is the transportation of the cargo using maritime transport over short distances. European Union (EU) transport statistics defined it as transportation of goods between the ports of EU. It includes also countries of EFTA. The case

where port of loading or discharge is located geographically within EU and other port is located on the Mediterranean or Black Sea is also defined as a short sea shipping. Shipping cargo from the Klaipeda to Gdynia is the example of the short sea services. (Commission Communication COM (1997) 317 final – 10.)

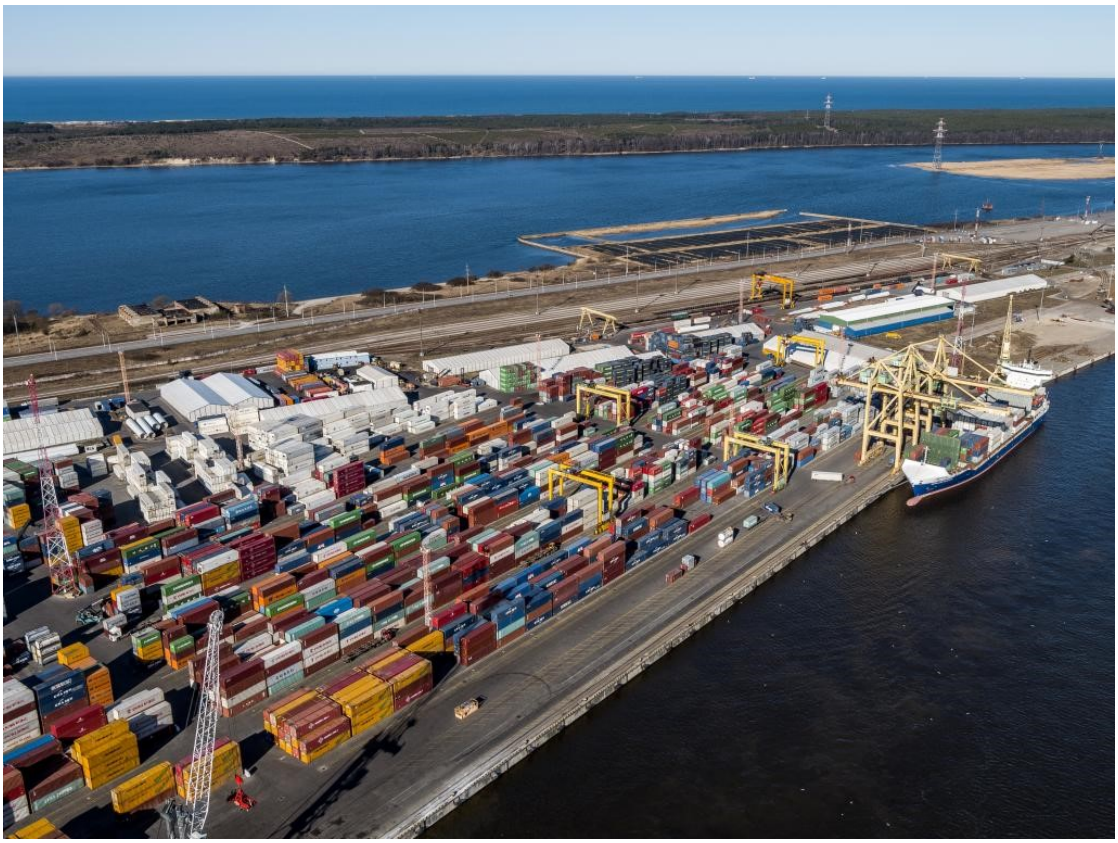

Figure 13. The Klaipeda Container Terminal

There are approximately 60 container vessels berth at the Klaipeda Container Terminal monthly. The terminal has the railway connection, as one the main ports of Lithuania. The railway services are provided by Viking Train and Containerships (a part of CMA CGM Group). Approximately, 15% of the all containers that are coming to Klaipeda, whenever it is export or import, arrive by rail. The Viking Train is one the most used services. The Viking Train line goes through the cities of Lithuania to Vilnius, Minsk, Belarus.The route goes via Moldova, Romania, Bulgaria and the final destination is the port of Istanbul, Turkey. (Klaipeda Container Terminal website)

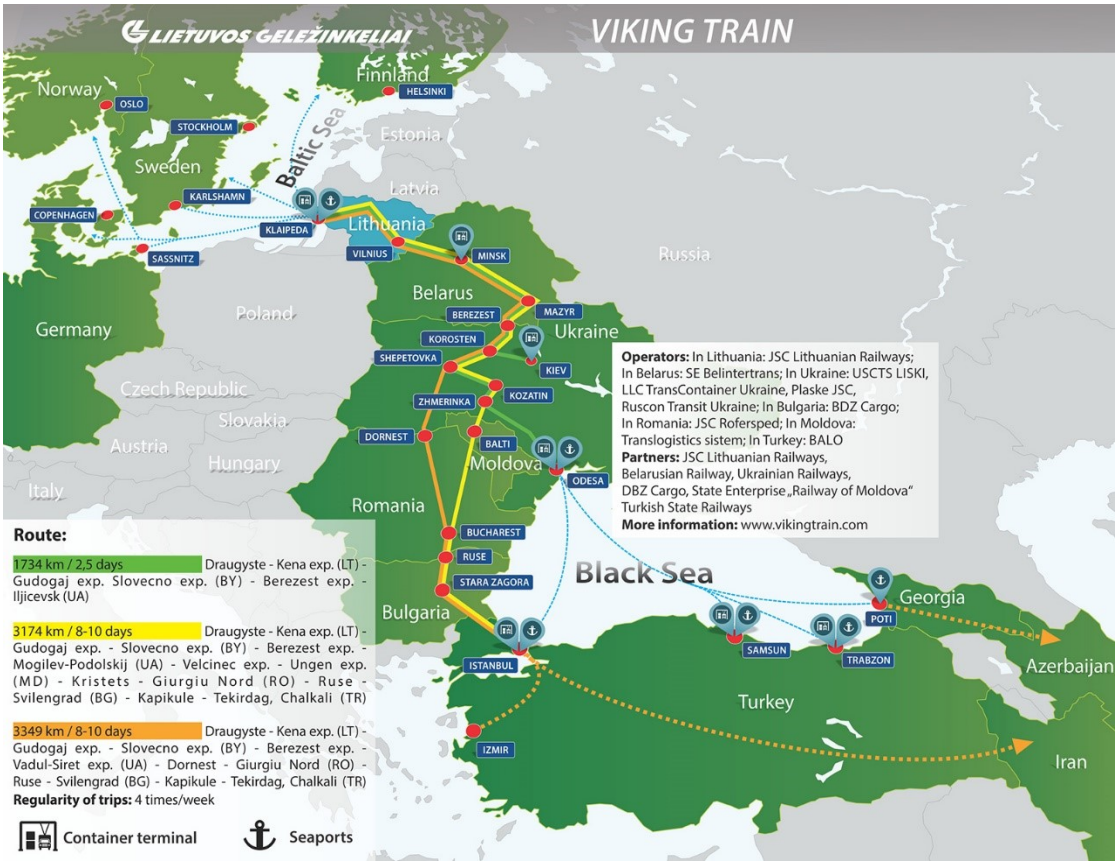

Figure 14. Viking Train (Viking Line website)

The Klaipeda Container Terminal is smaller than the HHLA TK Estonia and have the premise only of 32 ha. However, a warehouse area is 24000 m^2 compared to 20000 m^2 in Tallinn. Furthermore, a terminal has 4 railway tracks for 88 wagons. The refrigerated container possibilities are also bigger at Klaipeda than at Tallinn. 450 plugs against 404 at HHLA TK Estonia. The terminal provides basic services of every modern terminal:

- Handling all types of containers
- Services to reefer units
- Stripping and stuffing (CFS)
- Storage and weighing, VGM
- Container depot services
- Electronic reporting, EDI
- Handling OOG cargo and ro-ro cargo

5.8 Klaipeda import and export

Figures below represent import and export activity at the Klaipeda Container Terminal. Import means the full containers that are discharged from the vessel, picked up and unloaded by the customer, and returned empty after some time to the Klaipeda. Export means the empty containers that are going to the customers from the CMA CGM Group's stock. After a customer has stuffed the container, they are loaded full to the vessel to reach their port of destination or transshipment. The ideal situation for shipping business is when import is 5 – 10% higher than export. In such case, there are no additional supplies of empty equipment, in order to cover the demand, are required. If import is bigger than export, that means that there are more containers coming in than out and it provides room for a minor stock operational mistake. There is always should be the consideration that some part of the units from import, approximately 5 – 10%, are with some container damages. They should be repaired locally before, otherwise they might be not suitable for some cargo and safety loaded on the vessel. For all types of the containers mentioned below, safety stock means the approximate number of the containers needed to match export volumes until next supply of empty units arrives assuming that supply arrives weekly. Blank sailings, bad weather or other possible delays, which can occur irrespective of the logistics agent actions in Klaipeda, are not taken in account in the research, regarding empty supplies. All below mentioned data of containers that are flowing in and out of the terminal has been extracted from the CMA CGM Group's system and are presented in the graphical format for better understanding.

6 The Klaipeda Container Terminal storage position

KKT provides stock files with Excel and EDI. The CMA CGM Group and other companies who hold agreement with the Klaipeda Container Terminal receive a stock file in a Microsoft Excel format daily. The stock report includes all containers that are physi-

cally on ground are mentioned. The stock of each company is automatically generated from the terminal's system and sent to corresponding distribution list by the email. The Klaipeda Container Terminal stock includes:

- Container ID or number
- Booking reference, which reflects export or import booking reference. Sometimes terminal makes a remark for themselves in Lithuanian there.
- ISO code which represent container type
- Seals number. Also, can be referred as plombs. It allows to secure container safety. Seals are also used in the other than maritime shipping, for example in road transportation. Same seal number in port of loading or discharge represents that container has not been opened and amount or type of cargo has not been changed. It is almost impossible to open a container without ripping off the seal. Seals are monitored closely by customs as well. Often change of seals leads to additional customs checks.
- Physical location of the container. Can be referred also as storage position.
- Initial container status. Empty or Laden
- Current container status. Empty or Laden
- Weight of the unit
- Comment from the terminal, which is used by themselves
- Content description
- Arrival date of the container. It can be date of discharge from the vessel or gate in type by truck or train
- Vehicle type. Road/Rail or Sea
- Vehicle registration number or vessel name
- Arrival voyage ID
- Destuffing date
- Amount of dwell days for both empty and full

6.1.1 Storage location Desctription at Klaiepda Container Terminal

The container storage position is the main attribute in the Klaipeda Terminal stock report file. By knowing each letter or number meaning means it is possible to identify

not only the storage position of the container, but if unit is accessible and no extra lifts or additional costs are required in order to utilize the container. View of the container storage layout is presented in Figure 18. For better understanding, explanation of each segment of storage position except the last digit is included below. First letter and a number represent the storage location. Moreover, a number at the bottom and the top that presents the column lines. Row numbers are on the sides. The painted black area is reserved for the crane chassis to move back and forth.

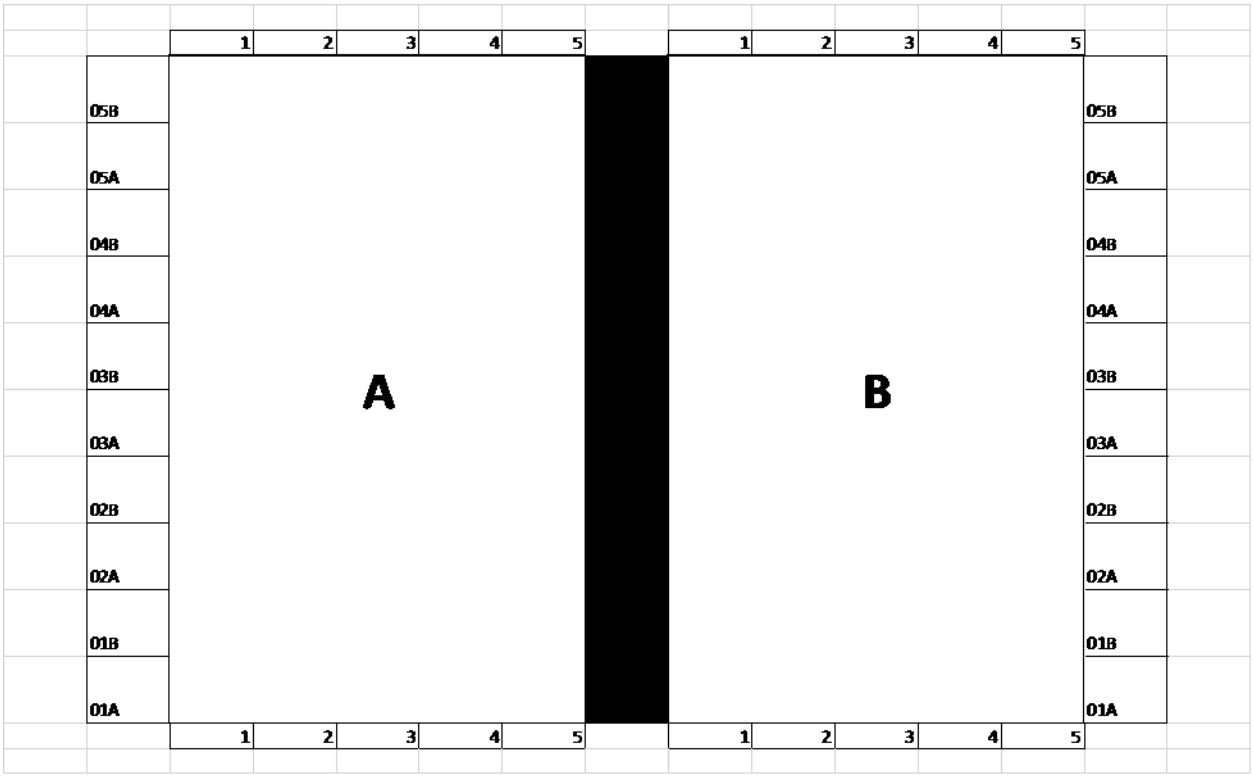

Figure 15. Container Storage Layout

The storage position is explained based on the example of the unit APZU3455656 with storage position A.1.07A.1. Letter A in the front represents the storage are A. Number 1 after first dot means column number 1. 07A shows the row position of the container. The last number – 1 after third dot represents the numerical position of the container from the ground, where the bottom container has value of one and the top container – as many units as in the pile. In our case 1 means that the container position is first from the bottom. According to the terminal's stock report, there are total of five containers in the pile and unit APZU3455656 is the lowest. The storage position is presented in Figures 19-20 from the top and from the side of pile below.

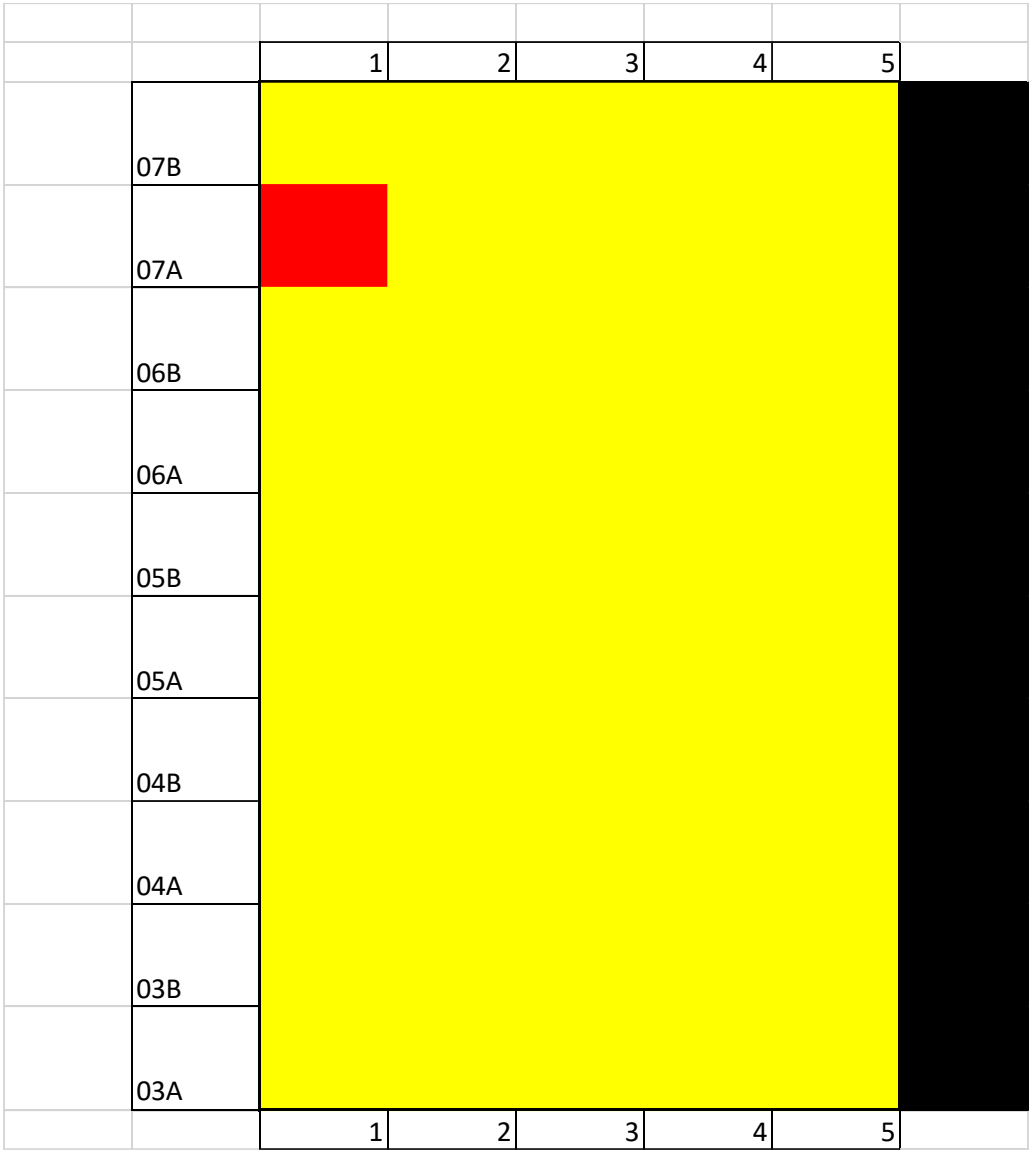

Figure 16. APZU3455656 Airborne Imagery

Figure 17. APZU3455656 Side View

When the report is executed with a Microsoft Excel VBA, Pivot table is generated that presents how many units are accessible and not. Accessible means whenever the unit can be picked up without extra lists, that means that unit is on the top of the pile. An Excel VBA identifies how many units are in pile. It compares storage positions of the units and identifying similar, but it takes into consideration only values before third dot, as the last value represents the position of the unit in the pile. It subtracts current position of the unit with the amount units in the pile and generates how many extra lifts are required.

Each container is divided into idling groups in order to have a better overview of the situation. The number of containers under each idling group advises how well the equipment rotation is happening at the terminal. Additionally, as already been mentioned before, if terminal charges storage costs based on the amount of container free days at the terminal, then the Group will be alert on storage costs and what actions should be taken in order to reduce storage costs. There are six idle groups are identified, and they are mentioned below:

- Less than 30 days
- From 30 to 60 days
- From 60 to 120 days
- From 120 to 160 days
- From 160 to 200 days
- More than 200+ days

After an Excel VBA is executed, there are three filter options are included. Moreover, more filters can be added by the user based on his preferences or requirements. Three filters that are automatically included mentioned below:

- Container ID, in case operator is looking for the specific container. It can be used to check if container is included in the stock or not. It can be used to show container availability as well.
- Container initial status that describes if the container was laden or not when it has been received at the terminal.

- Container current status that can be used to differentiate between empties and full. Every logistics controller or equipment officer is primarily interested in figures under empty units as major storage costs occur due to the idling empty containers. The full stock is usually moving fast because customers are obligated to pay detention and demurrages according to the bill of lading terms. The empty figures should be checked daily and full can be checked once per week. By using laden filter, it is possible to identify if there are any full units are long idling at the terminal with cancelled booking or just forgotten cargo

container_id	(All)					
content_curr	(All)					
content_init	(All)					
Count of LIFTS	**Column Labels**					
Row Labels	**0**	**1**	**2**	**3**	**4**	**Grand Total**
ACCESSIBLE	**888**					**888**
120-160 DAYS	5					5
160-200 DAYS	2					2
200+ DAYS	3					3
30-60 DAYS	158					158
60-120 DAYS	45					45
LESS THAN 30	675					675
NOT ACCESSIBLE		**541**	**440**	**383**	**245**	**1609**
120-160 DAYS				1		1
200+ DAYS			2			2
30-60 DAYS		112	108	102	69	391
60-120 DAYS		19	18	7	3	47
LESS THAN 30		410	312	273	173	1168
Grand Total	**888**	**541**	**440**	**383**	**245**	**2497**

Figure 18. Macro's result

Above mentioned Figure 21 visualize the example of the outcome. By knowing the amount of free time at the terminal, the logistics agent is able to identify how many containers are generating storage costs. Additionally, an agent can see how many units are accessible and containers idling days trend. Based on the macro result, it is possible to identify how many days specific container has been idling and what is his storage position, how many extra lifts are required to get the unit free. After these variables can be inserted in the formula described in the Chapter 7.10 in order to understand profitability of digging out unit immediately.

7 Costs related to the container handling operations

Currently, there is no clear system that is taking into consideration all factors and calculating the total cost of the container operations at the Klaipeda Container Terminal. The current cost understanding is coming from the experience of the logistics agent. Due to this issue the CMA CGM Group experience bigger expenses than it should for the container storage and container operations at Klaipeda Container Operations. The goal of the study is to provide the Group with the tool that will make container operations easier and present costs related to the container operations.

Since every port or terminal has it is own separate contract with the CMA CGM Group, each rate and charge will be different. One of the main factors that should be defined is the amount of days container is idling at the port. Below mentioned chapters described in detail what parameters company should pay attention to.

7.1 Idle time

Idle time reflects the amount of time the container has been physically at the terminal premises. The count begins when container has been gated-in full or empty. It can be done by truck, train or vessel. The storage costs count is for the container is stopped automatically when gate-out move happens or container is loaded on the vessel. In this formula the idle time is reflection the amount of days container has to idle in order to become free. In case container is free no additional lifts are required. Information concerning how unit idle time, can be obtained only directly from the terminal.

7.2 The cost of the lift

The cost defines the lifting of the container from the ground to the top of the pile of the other containers, from one pile to another pile, from truck or to truck and other possible movements involving the crane or forklift. However, in maritime, as soon as

crane or forklift puts the container on the ground or car, next lift counted as separate.

7.3 Extra working hours

There are some countries where the additional payment to the employee is required by law dependent on the day when the action is taken place. One of such countries is Finland. Subsequently, if any operations are required to be done during weekend or public holiday, additional charges are applied. Additional payment must be checked directly with the terminal due to the country of terminal's residence legislation and the agreements they hold with the employees of the terminal.

7.4 Extra Costs

Extra costs represent charges are occurring due to the processes. It can reflect Forklift oil price, in case maintenance is planned later, but the process requires forklift operations immediately. It can be spare part material that needs to be purchased in order to complete maintenance and repair cycle. These costs are advised directly by the terminal or vessel operator in advance and the CMA CGM Group has no power to predict them.

7.5 The amount of additional lifts required

The number of lifts refers to the amount of forklift or crane movements that are required to complete the operation for a specific container. Not every empty container is immediately accessible at the terminal. The Klaipeda Container Terminal stores the biggest number of the containers within the area of scope of Finland and the Baltic Cluster. Amount of lifts defines; how many lifts and what operations are required to get the container to make unit accessible or to be placed to the desired position.

7.6 Storage cost including free time at port if possible

As already mentioned, due to the separate agreements with the terminals, storage costs are calculated differently for each case. Therefore, usually there are two the most common types of storage cost of empty containers at the terminal:

- Storage cost based on the amount of days that an empty container idles at the terminal until next gate out, in or load on board move.
- Storage cost based on the number of containers at the terminal, where cost for exceeding free number of units is defined by agreement. The storage cost can be free for first 800 TEUs and after that some amount stated in the agreement applied. It can be also defined by specific amount of TEU and made up in the groups.

However, it should be taken into consideration that agreements might change during a year or after a specific period. Sometimes additional parts of the agreement start to apply, for example if during one-year period amount of TEU exceeded by 35000 TEU, then next time the amount of free empty pool range at the terminal expands from 800 TEU to 1000 TEU.

7.7 The Container rental cost

As mentioned in abstract 4.3, not all containers belong to the CMA CGM Group. Some part of it is rented out from other containers' companies. The Group holds agreement on each group of containers or single containers an agreement, where it is stated what is the rental cost that the Group must pay. An agreement might have a different regulation and term as each container is unique.

7.8 Shunting between terminals

For some cases the shunting between the terminals is required. Shunting might be performed for a specific type of equipment which cannot be utilized at the current

terminal but can be used on the other. In such case cost will include the transportation cost, lift on the truck or ship and lift from the transport. Reasons for shunting units between the terminal can be for example client needs or specific maintenance and repair services.

Shunting is a movement of trailers within a port or terminal area or between terminals/ports. Usually performed by trucks but can be performed by rail as well. (Glossary of Vehicle Logistics Terminology - 2015, 15.)

7.9 The Vessel rates

Even though the CMA CGM Group has its own vessels, in the Baltic region the movement of the containers are primary outsourced from the third-party shipping company. The vessel rate means costs that the shipper pays to the transportation company to bring the container/cargo from location A to location B. The rate usually includes BAF in it. BAF – Bunker Adjustment Factor, is a fuel charge that shipping companies use for the fuel price fluctuations in order to secure profit. (Glossary of Vehicle Logistics Terminology – 2015, 6.)

Recently, the Containerships Group became a part of the CMA CGM Group and now the CMA CGM can move empties by using the Containerships' vessels that are faster. The only disadvantage the Containerships' vessels have is the specific terminals are not called. For example, their vessels do not call BCT terminal in Riga or Port of Tallinn.

7.10 Formula

The below mentioned formula is taking in the account all above mentioned variables from the Chapter 5.9. After the formula, there is an explanation on what is the meaning behind of each variable and which one of them are not necessary to take into consideration in some cases.

$$Decision = Costs\ of\ extra\ lifts\ /\ Storage\ cost$$

The ***Decision*** reflects if logistics agent should proceed with digging the unit out of the pile of the containers or not. The value of the Decision can be only positive. If the cost of extra lifts is bigger than the storage cost, the value is of the Decision is more than one, then the decision will be negative. The logistics agent should wait as it will cost more to dig out the unit rather than wait. If the value of Decision is less or equal one, then the logistics agent should dig out the unit as he saves money or does not generate any additional unnecessary expenses compared to waiting option, where it is necessary to wait until a unit becomes free.

$$Cost\ of\ extra\ lists = Costs\ per\ lift\ per\ TEU * Amount\ of\ TEUs * Amount\ of\ Extra\ Lifts + Cost\ per\ Extra\ Hours * Number\ of\ Extra\ Hours + Shunting + Vessel\ Rate + Extra\ Costs$$

Amount of TEUs represents the value between one and two, where it shows the amount of TEUs container represents respectively. If the terminal does not charge cost of the lifts based on the number of TEUs then value of the Amount of TEUs is always set to one. In this case the amount of TEUs will be considered only once.

One of the most critical points to identify, before proceeding to the storage costs formula, is to understand if the storage cost at the terminal has occurred. The storage cost can be dependent on the free pool or amount of free days at the terminal. Two scenarios of how the storage cost is calculated presented below:

$$Storage\ cost\ if\ free\ pool\ or\ amount\ of\ free\ days\ is\ exceeded = Amount\ of\ days\ Container\ must\ idle\ to\ get\ free * Amount\ of\ TEUs * Storage\ Cost\ of\ Container\ per\ Day + Amount\ of\ days\ Container\ has\ to\ idle\ to\ get\ free * Rental\ Cost\ of\ Container$$

$$Storage\ cost\ if\ free\ pool\ or\ amount\ of\ free\ days\ is\ not\ exceeded = Amount\ of\ days\ Container\ must\ idle\ to\ get\ free * Rental\ Cost\ of\ Container$$

The formula presents to the logistics agent the comparison of the container operations cost and the cost of the container idle time. The cost of the container idle time is based on the storage cost at the terminal and the container rental costs if it is present. Based on the cost figures the logistics agent will be advised how to proceed with the specific container in order to minimize the costs at the Klaipeda Container Terminal. The formula works automatically as most of the variables are constant or do not change often.

8 Conclusion

Currently, the CMA CGM Group does have a tool to identify the deficit and surplus of the containers at different areas. The tool is used to define how to organize the container flow to the areas in need. However, the company does not have a tool to achieve the clear understanding behind the storage invoices that the Klaipeda Container Terminal is sending. Additionally, the CMA CGM Group does not have the tool to identify the containers that are currently or potentially generating storage costs at the Klaipeda Container Terminal.

9 Discussion

The study has generated the result where the CMA CGM Group is now capable of identifying the storage costs and the container operational costs at the Klaipeda Container Terminal. The result has been successful and has been tested on different stock reports provided by the Klaipeda Container Terminal. The study provides the possibility for future development of the various factors that are generating costs not only at the Klaipeda Container Terminal but other areas under control of the Group. The research results can be also beneficial for the other container shipping lines that are holding agreement with the Klaipeda Container Terminal.

The research could have had broader data from the CMA CGM Group's ERP, for example for ten years. Finland and the Baltic Cluster has been established only 4 years ago. Therefore, the container data in the Klaipeda Container Terminal is not accessible. The container rental agreements that the CMA CGM Group holds with various container leasing companies could be also used in the research. However, the data is only accessible from the head office in Marseille.

The results are reliable. If someone carries out research with similar condition as current, the results will not change drastically. There are only two possible condition, such as economic situation in the world or Lithuania and seasonality, that could affect the research results. However, both conditions happen irrespectively of the CMA CGM Group action and the company does not have the control over such conditions.

The result can be expanded to the other terminals in Finland and the Baltic cluster at the CMA CGM Group in the future. The cost calculation file can be easily modified, and some parts can be removed. New parts could be added based on the country, region or terminal practices. One of the main disadvantages that system relies on is the container storage position at the terminal and macro file created for the Klaipeda Container Terminal. The solution might not work and comply with the reporting style of other the terminals. It is hard and almost impossible to amend the terminal's stock reporting style as they are generated automatically from the terminal's system. In order for terminal to change it, major IT investment has to be performed. Similar problem in some areas might be that the terminal does not provide container storage positions at the terminal and uses them only for the internal purposes. In that case, it is impossible to know container storage positions as the terminal is not allowed to disclose that information to other parties.

The research opens a possibility for the future development. The software, using Python or Java programming language, can be created in order to automatize the current system even more, based on the formulas from the current research. As already mentioned before, research could have had the different result due to the different economic situation and seasonality. Furthermore, the future research can be applied to identify the correlation between the economic situation, sale and the container

operational costs, whenever it is more challenging to control container operational cost during the high demand seasonality and whenever it adds additional costs on top of existing or neglects some of it.

9.1 Refection

During the process of writing this thesis, I have released how limited is my knowledge in the field of logistics. I believe I would make more detailed research if I had a deeper knowledge and access to the other details, such as bigger historical data. The wider data would help to identify the correlation between idling containers and number of containers at port or export activity. Better forecasting could be achieved by including commercial input into it. The outcome would probably stay relatively the same but would be broader. I believe that my research has been successful and be used as the base for the more detailed research and optimization of other locations in the future.

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